



# **MARKSCHEME**

**May 2011**

**BIOLOGY**

**Standard Level**

**Paper 3**

16 pages

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## General Marking Instructions

### Subject Details: **Biology SL Paper 3 Markscheme**

#### Mark Allocation

Candidates are required to answer questions from **TWO** of the Options [**2 × 18 marks**].  
Maximum total = [**36 marks**].

1. A markscheme often has more marking points than the total allows. This is intentional. Do **not** award more than the maximum marks allowed for part of a question.
2. Each marking point has a separate line and the end is signified by means of a semicolon (;).
3. An alternative answer or wording is indicated in the markscheme by a slash (/). Either wording can be accepted.
4. Words in brackets ( ) in the markscheme are not necessary to gain the mark.
5. Words that are underlined are essential for the mark.
6. The order of marking points does not have to be as in the markscheme, unless stated otherwise.
7. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the markscheme then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by writing **OWTTE** (or words to that effect).
8. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized.
9. Only consider units at the end of a calculation.

**Option A — Human nutrition and health**

- A1. (a) (i) summer [1]
- (ii) Geelong and (Southeast) Queensland (*both needed*) [1]
- (iii)  $(40 - 8) = 32\%$  (*accept answers in the range of 31% to 33%*) [1]
- (b) *similarity:*  
none of the locations are deficient in Summer;  
Geelong and (Southeast) Queensland have similar prevalence/levels of deficiency at all times of the year;
- difference:*  
only Tasmania shows a deficiency in autumn;  
Tasmania shows the highest prevalence of deficiency;  
(Southeast) Queensland shows less prevalence/levels of deficiency overall; [3 max]  
*To award [3], answers must address at least one similarity and one difference.*
- (c) diets rich in vitamin D could raise vitamin D levels; (*vice versa*)  
use of sunscreen/staying out of the sun/hats/clothing can reduce the production of vitamin D by the skin; (*vice versa*)  
use of dietary supplements containing vitamin D can reduce deficiency levels; [2 max]

- A2.** (a) (per 100 g) fat contains more energy than protein or carbohydrate / fat has higher energy content (per 100 g);  
fat contains (approximately) twice the number of joules/energy per gram than proteins and/or carbohydrates;  
(per 100 g) fats have approximately 4000 kJ, whereas carbohydrates have 1760 kJ and proteins have 1720 kJ; **[1 max]**
- (b) lack of blood plasma proteins and tissue fluid retention/abdominal bloating/swollen abdomen;  
kwashiorkor/marasmus develops;  
poor growth and development (among children);  
(often) mental retardation;  
lethargic/little interest in surroundings;  
wasting of muscle / thin muscles; **[2 max]**
- (c) (consuming animals or animal products) may reduce problems of malnutrition/hunger  
appropriate use of antibiotics improves health of livestock/may cause antibiotic resistance/side effects/allergies;  
killing animals is wrong/against (some) religious beliefs;  
overeating leads to health problems/cardiovascular disease/obesity;  
animal foods are from organisms higher up the food chain/more energy (per acre) available to humans with a plant diet than with an animal diet/animal diet has a higher ecological footprint; (*vice versa*)  
poor treatment of animals raised for food / example of ill treatment of animals;  
destruction of ecosystems;  
introduction of hormones, into the human food supply/environment;  
hunting could lead to species extinction;  
eating animals/animal products may be necessary for human survival; **[4 max]**
- A3.** *cause:* **[1 max]**  
a genetic variation/mutation;  
change in gene coding for tyrosine hydroxylase;
- consequences:* **[1 max]**  
results in a failure to metabolize phenylalanine into tyrosine;  
results in high levels of ketones in the blood and urine;  
results in mental retardation/brain damage;
- diagnosis:* **[1 max]**  
can be made by a simple blood test for the level of phenylalanine;  
diagnosis can be made shortly after birth; **[3 max]**

**Option B — Physiology of exercise**

- B1.** (a) (i) standing position [1]
- (ii) leg muscles are not pumping/contracting to help return of blood to the heart;  
gravity pulls the blood back towards feet / circulation must overcome gravity to return blood to heart; [1 max]

(b) 340 (arbitrary units) [1]

- (c) better oxygenation enhances muscle metabolism;  
better blood flow/cardiovascular fitness  
prevents pooling/swelling of ankles and feet/varicose veins;  
prevention of thrombosis;  
maintenance of muscle strength from better circulation;  
maintenance of muscle strength from use of muscles; [3 max]

**B2.** (a) (i) (muscle) A (is relaxed) [1]

- (ii) Z-lines are farther apart;  
there is a light band on either side of the M-line / light bands are wider;  
the sarcomere is longer/bigger; [2 max]

(b) *Award marks for paired statements only. Answers do not need to be shown in a table format.*

characteristic	fast muscle fibres	slow muscle fibres
blood supply	moderate / some capillaries	excellent / many capillaries;
myoglobin	little present	large stores;
mitochondria	few present	many present;
cell respiration	high anaerobic capacity / requires less oxygen	high aerobic capacity / high oxygen requirement;
stamina	low / maximum work rate in short time / sprinter / fatigue easily	high / sustained work rate / marathon runners / resists fatigue;
strength	high	low / moderate;

**[3 max]**

- B3.** (a) (i) physical condition of a body that allows it to perform exercise of a particular type *[1]*
- (ii) speed is rate of movement;  
stamina is the capacity for sustained performance/exercise;  
measures of fitness/agility/strength can be used to show improvement in performance;  
shortening of time for heart to return to resting rate; *[2 max]*
- (b) training causes enlargement/strengthening of heart muscle due to increased work/contractions;  
(this strengthening is) especially in the left ventricle;  
cardiac output increases as a result of increased heart rate (during training);  
cardiac output increases as a result of increased stroke volume (due to stronger heart muscle);  
greater movement of blood improves delivery of oxygen for aerobic respiration (to the heart muscle);  
(basal) heart rate of a trained individual is lower than that of an untrained individual due to a stronger heart muscle; *[3 max]*

**Option C — Cells and energy**

- C1.** (a) 40 °C [1]
- (b) 40 °C : 3.5  $\mu\text{mol m}^{-2} \text{s}^{-1}$ ; (units required)  
 Accept answers between 3.0  $\mu\text{mol m}^{-2} \text{s}^{-1}$  and 4.0  $\mu\text{mol m}^{-2} \text{s}^{-1}$ .
- 50 °C : 10  $\mu\text{mol m}^{-2} \text{s}^{-1}$ ; (units required) [2]  
 Accept answers between 9  $\mu\text{mol m}^{-2} \text{s}^{-1}$  and 11  $\mu\text{mol m}^{-2} \text{s}^{-1}$ .
- (c) rate of respiration is increasing [1]
- (d) (i) rate increases as the temperature increases up to a point/40 °C and then decreases [1]
- (ii) at low temperatures/between 25 °C and 35 °C the rate of photosynthesis increases and the rate of respiration is (approximately) constant;  
 between 35 °C and 40 °C both increase;  
 as temperature continues to increase the rate of photosynthesis reaches optimum whereas rate of respiration decreases less/stays constant/increases;  
 at high temperatures/between 40 °C and 50 °C photosynthesis decreases as respiration decreases less/stays constant/increases; [2 max]

**C2.** (a) Award marks for paired statements only. Answers do not need to be shown in a table format. To award [3 max], a named example must be given.

fibrous proteins	globular proteins
long and narrow	round shaped;
generally insoluble in water	generally soluble in water;
(tend to) have structural role	(tend to) have functional/metabolic role;
named example e.g. collagen/myosin	named example e.g. hemoglobin/ immunoglobulin;

[3 max]

(b) Award marks for paired statements only. Answers do not need to be shown in a table format.

competitive inhibition	non-competitive inhibition
the inhibitor and substrate are very similar	the inhibitor and substrate are not similar;
attach to the active site	bind away from the active site;
block the active site	change the shape of the active site;
inhibition (of the active site) is reversible	inhibition (of the active site) is irreversible;
increase in substrate concentration affects/reduces inhibition	increase in substrate concentration does not affect/reduce inhibition;

[4 max]



- C3.** pyruvate (from glycolysis) enters a mitochondrion;  
enzymes in the matrix remove one carbon dioxide and hydrogen from the pyruvate;  
hydrogen is accepted by NAD/forms NADH;  
removal of hydrogen is oxidation;  
removal of carbon dioxide is decarboxylation;  
the whole process/link reaction is oxidative decarboxylation;  
the product is an acetyl group which reacts with CoA/coenzyme A;  
acetyl CoA enters Krebs cycle;
- Accept any of the above points in the form of a clearly drawn and correctly labelled diagram.*

**[4 max]**

**Option D — Evolution**

- D1.** (a) (i) Pine Warblers/*Dendroica pinus* (of Delmarva) [1]
- (ii) 2.6 mm (*accept answers in the range of 2.5 mm to 2.7 mm*) [1]
- (iii) Yellow-throated Warblers have a bigger range / greater variation (of beak length) in Delmarva than in Midwest (*accept numerical values*) [1]  
*Accept converse.*
- (b) allows them to eat other foods / changes feeding behaviour;  
reduces competition with Pine Warblers; [1 max]
- (c) allopatric speciation occurs between populations that live in different areas;  
(when populations are geographically isolated) there is no interbreeding;  
natural selection works on each population independently;  
competition with the Pine Warbler only occurs in Delmarva / the Pine Warbler acts as selective pressure on the Yellow-throated Warbler in Delmarva;  
eventually Yellow-throated Warblers in the two areas could become two species instead of one / *OWTTE*;  
*Award [2 max] if no reference to Warbler.* [3 max]
- D2.** (a) non-living synthesis of simple organic molecules;  
assembly of simple organic molecules into polymers;  
origin of self-replicating molecules/RNA;  
packaging of molecules inside membranes with different internal chemistry from surroundings; [3 max]  
*Do not accept references to reducing atmosphere unless part of a process.*
- (b) (prokaryotes) used hydrogen from water in synthesis and released oxygen;  
(prokaryotes) produced oxygen during photosynthesis;  
atmosphere changed from a reducing atmosphere to an oxidizing atmosphere;  
current life forms depend upon an oxygen-rich atmosphere; [2 max]
- D3.** few hominid fossils have been found/not often found/are very rare;  
most hominids/organisms not preserved/decompose;  
only teeth and bones remain / soft tissues do not fossilize;  
require certain conditions for preservation/dry/anaerobic/quickly covered/frozen;  
earlier cultures did not bury the dead / remains were scavenged/dispersed;  
acids break down/dissolve teeth/bones;  
many missing links/fossils of intermediate stages;  
difficult to get conclusive evidence / difficult to falsify theories;  
theories change radically with one/few discoveries; [6 max]

**Option E — Neurobiology and behaviour**

E1. (a) 15 days [1]

(b)  $13 - 9 = 4(\text{days})$  *or*  $\frac{4(\text{days})}{13(\text{days})} \times 100$  *or*  $100 - 69.2$ ;  
 31% *or* 30.8% *or* 30.77%; [2]

(c) both types of sound decreased mean time to egg laying;  
 extra-colony sound decreased time more than intra-colony;  
 both types of sound increased (mean) number of eggs laid;  
 same (increase in) egg number with intra- and extra-colony sound;  
 no information on sample sizes/number of pairs/egg size;  
 competition (implied/perceived) leads to earlier egg laying; [3 max]  
*Answers must evaluate the effect of the sounds, not merely compare the results.*

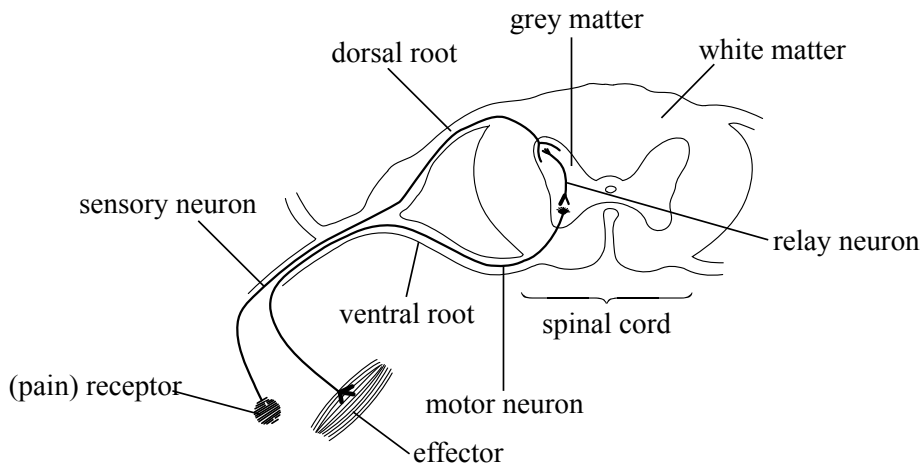
E2. *Diagrams are to include the following structures appropriately drawn and in appropriate relationship to each other.*

- (pain) receptor indicated at the dendrite end of the sensory neuron;
- sensory neuron shown in appropriate abbreviated shape from a (pain) receptor to the central nervous system (CNS) with dendrites and axon;
- dorsal root ganglion shown next to the CNS;
- relay neuron/interneuron/associative neuron shown in the CNS/spinal cord with dendrites and axon;
- motor neuron shown with dendrites and axon from the CNS to an effector;
- effector/muscle labelled as a muscle;
- white matter shown correctly in the spinal cord;
- grey matter shown correctly in the spinal cord;
- spinal cord shown connected to the brain and with appropriate position relative to the structures given above;

[4 max]

*Award [3 max] for inaccurate diagrams.*

**N.B.** *Accept stylized diagrams of neurons.*



- E3.** (a) *excitatory*: cocaine / nicotine / amphetamines;  
*inhibitory*: benzodiazepines / alcohol / THC; [2]  
*Accept other suitable examples.*
- (b) excitatory (psychoactive) drug;  
cocaine attaches to dopamine pumps/transporters (on presynaptic membrane);  
blocks uptake/recycling / causes dopamine to persist in the synaptic cleft;  
amplifies synaptic transmission / causes constant stimulation of postsynaptic  
neuron;  
causes euphoria/feelings of happiness/pleasurable effects; [3 max]
- (c) addictive drugs trigger secretion of dopamine which causes feelings of pleasure/  
well-being/reward / users become dependent on feelings;  
genetic predisposition is most common with addiction to alcohol;  
social factors affect the incidence of addiction;  
it is not certain that a person who is genetically predisposed will develop addiction  
when exposed to the drug / *OWTTE*;  
although many drugs are (potentially) addictive, not every user becomes an addict;  
*named social factors which must be explained:*  
*e.g.* cultural traditions / peer pressure;  
social deprivation / traumatic life experiences / mental problems; [3 max]

**Option F — Microbes and biotechnology**

- F1.** (a) (i)  $1.6 \text{ (units) cm}^{-3}$  (accept answers in the range of  $1.5 \text{ units cm}^{-3}$  and  $1.7 \text{ units cm}^{-3}$ ) [1]
- (ii)  $8.3 \text{ (units) cm}^{-3}$  (accept answers in the range of  $8.2 \text{ units cm}^{-3}$  and  $8.4 \text{ units cm}^{-3}$ ) [1]
- (b) as fermentation time increases laccase production rises then falls;  
 as veratryl alcohol concentration increases laccase production rises then falls;  
 optimum fermentation time is 4.75/5.0/5.25 days;  
 most laccase overall with low veratryl alcohol concentration and long fermentation; (accept converse)  
 optimum veratryl alcohol concentration is 33/34/35  $\text{mmol dm}^{-3}$ ;  
 fermentation time has greater effect than veratryl alcohol concentration; [3 max]
- (c) the best time for fermentation appears to be 4.75 days; (allow 4.75 to 5.25 days)  
 with a veratryl alcohol concentration of  $33 \text{ mmol dm}^{-3}$  / moderate veratryl alcohol concentration; (allow 33 to  $35 \text{ mmol dm}^{-3}$ ) [2]
- F2.** (a) gene therapy involves replacing defective genes;  
 desired gene is inserted into the viral genome;  
 viruses can be modified to infect only target cells and not self-replicate / modified for safe use;  
 somatic cells are removed (for receiving the new genes);  
 the desired gene is introduced into the target/somatic cells;  
 altered cells are returned to the patient for expression of the gene;  
 properly described verified example e.g. replacement of gene for production of ADA in SCID / introduction of gene/RPE65 (in retina) to restore vision in inherited blindness (LCA) / replacement of factor IX/blood clotting factor gene in hemophilic patients; [3 max]
- (b) *Aspergillus* is (a fungus) used to produce soy sauce;  
*(Aspergillus)* breaks down the proteins/carbohydrates/starch;  
*(Lactobacillus)* bacteria and yeasts are used;  
 hydrolysis/lactic fermentation/alcoholic fermentation (of starch and proteins) yields alcohol/organic acids/sugars/amino acids;  
 mixture is pasteurized (to kill the microorganisms); [3 max]

- F3.** (a) denitrification is favoured by anaerobic conditions in soil;  
poor drainage/waterlogged soils;  
slightly alkaline;  
suitable temperature;  
the presence of denitrifying bacteria/*Pseudomonas (denitrificans)*; **[1 max]**
- (b) pH changes;  
raw sewage often contains pathogens that cause disease;  
increase in nutrients/nitrates (from fertilizer) leads to eutrophication;  
decomposition of organic matter releases ammonia into water;  
ammonia is converted into nitrate;  
nitrate causes algal bloom;  
bacteria that feed on sewage cause high BOD/lack of (dissolved) oxygen;  
lack of oxygen may kill fish/other aquatic life;  
as algae release oxygen into water via photosynthesis, water recovers downstream; **[4 max]**

**Option G — Ecology and conservation**

- G1.** (a) 260 pmol mg<sup>-1</sup> (accept answers in the range of 255 pmol mg<sup>-1</sup> to 265 pmol mg<sup>-1</sup>) [1]
- (b) *Neobisium muscorum*;  
level of cadmium remains high / does not decrease (when cadmium is removed); [2]
- (c) (i) *Notiophilus biguttatus* [1]
- (ii) can excrete/remove/eliminate cadmium (from its tissues);  
faster reduction/removal / drops to lowest level after cadmium exposure;  
cadmium levels stop rising sooner/rise slowing by day ten;  
is less tolerant/dies when cadmium reaches a certain concentration;  
exposed to cadmium for a shorter time/period; [2 max]
- (d) cadmium accumulates along food chain / biomagnification / bioaccumulation;  
heavy metals cause abnormal growth/behaviour/death/failure to reproduce;  
*Notiophilus biguttatus* has less effect on the food chain (as it accumulates less);  
cadmium harmful/lethal to organisms at/near the end of the food chain;  
(death of arthropods) may change soil quality; [2 max]
- G2.** (a) (ecological niche is) mode of existence/role of an organism within its ecosystem;  
(ecological niche includes) its habitat/abiotic factors of the environment;  
(ecological niche includes) what the species eats / how the species obtains food;  
(ecological niche includes) interactions with other species;  
(ecological niche includes) the set of all ranges of limiting factors an organism tolerates / *OWTTE*; [2 max]
- (b) fundamental niche is the niche for which a species has adaptations for success/potential mode of existence whereas a realized niche of a species is its actual mode of existence;  
the realized niche is often smaller than the fundamental niche (of a species);  
competition/predation is reason for the differences (between fundamental and realized niches); [2 max]

- G3. (a) correctly named biome;  
 temperature range;  
 dominant plant/ecosystem characteristics;  
*Allow any other appropriate characteristic.*

[3 max]

*e.g.:*

temperate deciduous forest;  
 warm/15–18°C summers and cold/3–7°C winters / significant annual temperature variation;  
 broad leaf trees (that lose leaves annually) / significant diversity of understory plants;

*The following provides further examples of biomes that may be addressed. Answers do not need to be shown in a table format.*

named biome	temperature range	dominant plant / ecosystem characteristics
desert;	hot (30°C+) in day and cold (below zero) at night ;	xerophytes / succulent / sparse low-lying bushes adapted to water conservation;
savannah;	hot (20–30°C);	grasslands with widely spaced trees;
tropical rainforest;	very hot (25–30°C);	epiphytes / trees and wide leaf plants in undergrowth / huge diversity / tall mature trees of many species;
taiga;	cold (below 0–15°C);	coniferous/evergreen trees densely packed (few species);
tundra;	minus temperatures for most of the year;	small and close to ground / grasses and mosses with a few small trees (perennial herbs grow in summer);

- (b) animal distribution is related to abiotic and biotic (niche) requirements;  
 temperature must be within viable range based upon the adaptations of the animal;  
 water must be available in species-specific quantities (Gila lizards require less water than elephants);  
 breeding sites are required for maintenance of the species;  
 food supply must be of the right kind for the species (*e.g.* nuts for squirrels and leaves for rabbits);  
 territory is required for some species for breeding/feeding;  
 dissolved oxygen affects aquatic species as some organisms can tolerate low levels of oxygen;  
 salinity effects distribution as some species are more sensitive than others to salt;  
 other appropriate answers with justification are acceptable;

[3 max]